M.O. 381.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 70

April 1935

No. 831

LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

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On- and Off-Shore Winds in East Africa

It was thought that the following notes on some new diagrams of air movement might be interesting as a somewhat unusual method of construction, and perhaps more especially as showing how well-marked on- and off-shore breezes can be, on the shores of both sea and lake.

In constructing a rainfall map of Uganda, Tanganyika and Kenya, it was decided to make use of a certain amount of interpolation, aided by all possible external evidence, in drawing the isohyets. Thus, although the rainfall totals for many stations, when considered in relation to the relief features of the area, gave in themselves definite evidence of a rain-shadow effect, this evidence was supplemented by reference to wind direction diagrams, which were obtainable from a limited number of stations.

Among the stations collecting data of this nature are three First Order Meteorological Stations set up at Kololo Hill (Kampala, Uganda, altitude 1,310 m.), Kabete (near Nairobi, Kenya, altitude 1,830 m.), and Chukwani (Zanzibar, altitude 20 m.) during 1931 and 1932. From the monthly records of these stations it is now possible to obtain hourly wind readings throughout the year. These readings indicate (*a*) direction, at 5° intervals, and (*b*) velocity, in metres per second, to the nearest tenth of a metre per second. From these figures wind roses were constructed, which appeared to possess considerable interest in themselves, particularly those from Chukwani

and Kololo Hill, which showed in a striking manner the incidence of the on- and off-shore breezes in relation to the dominant winds.

It was difficult at first to decide in what manner the diagrams should be constructed, in order to give the most satisfactory indication of total air flow from different directions. Finally the following method was adopted. A circular diagram was drawn, consisting of concentric circles at regular intervals apart, and with radii drawn at 5° intervals. At the same time it was decided to sum the total velocities recorded from each direction. On each radius a mark was then placed at a distance from the centre proportional to the sum of the velocities. Thus were plotted the points A B C D, as on the accompanying figure (Fig. 1). It was intended next to join up these points to form a continuous line. But, before doing this, one modification had to be introduced, since it was found that, presumably owing to human error in reading the graphic record of the Dines pressure-tube anemometer, there was invariably a higher quantum at angles consisting of whole 10°s. To overcome the gross irregularities which this obvious error would have given to the curve, a moving average of adjacent pairs was used, and this gave the line joining the points X Y Z. There are some other irregularities in the curves on each diagram, especially those for Kololo Hill, but it was not thought advisable to attempt to eliminate them.

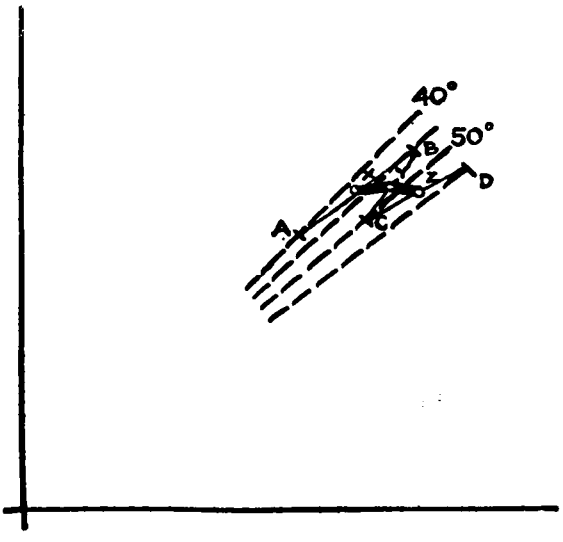


FIG. 1.

The interest of the diagrams appears to be twofold. Not only do they show the very striking effect of on- and off-shore breezes in east Africa, but also, it is suggested, the method of combining velocities and directions in this way might demonstrate the incidence of such breezes in diagrammatic form more readily than if directions alone were plotted. This was shown in the case of the Kololo Hill Station by drawing a conventional wind-rose, in which the total effect of the air movement in each direction, although still in this case fairly clear, was rather inclined to be lost, since velocities varied from one direction to another. Thus the method might possibly be applied with advantage in other areas, where the effect of the breezes is not so markedly distinct as in East Africa.

Fig. 2 shows the diagram for Kololo Hill for October, 1931. It is

not known how far these readings are typical, since no readings for the same month in subsequent years are as yet available. The dotted

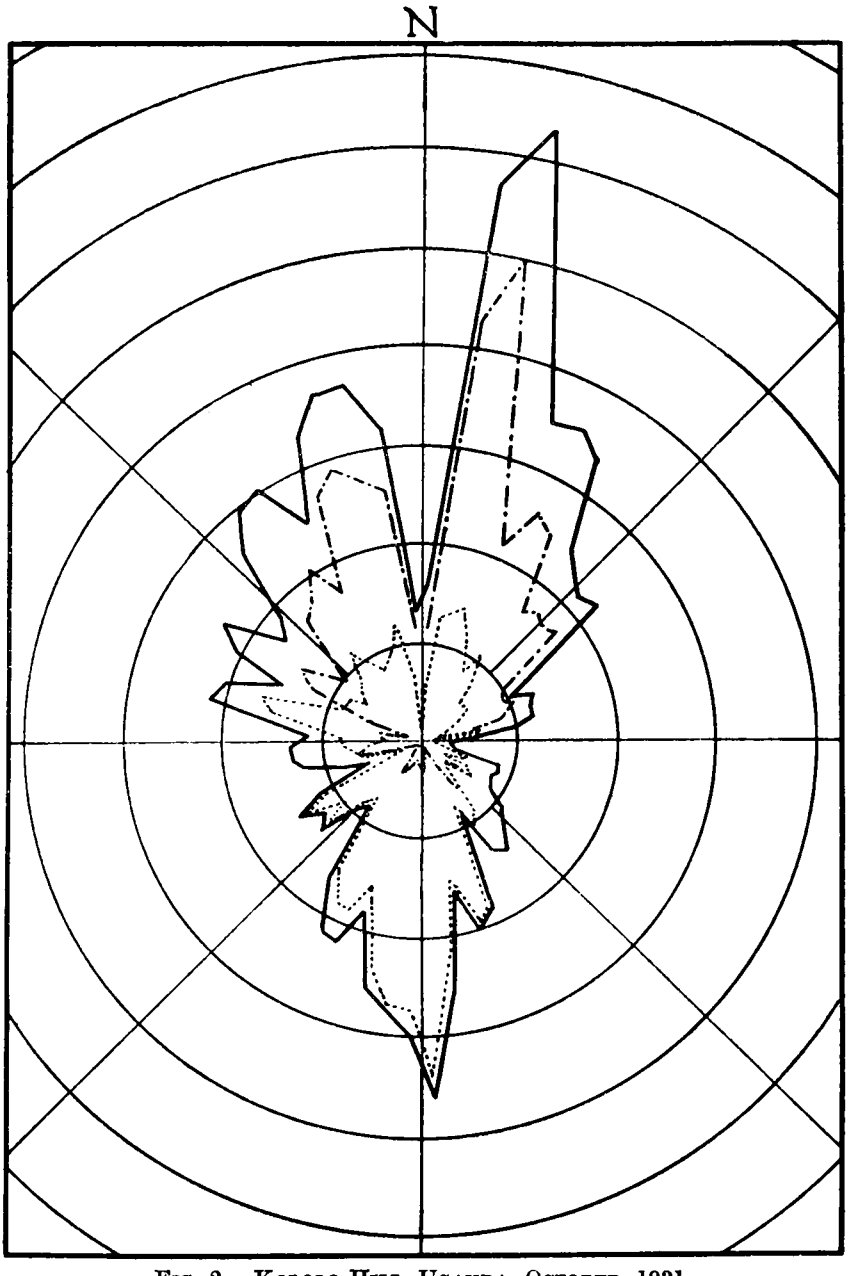


FIG. 2. KOLOLO HILL, UGANDA, OCTOBER, 1931.

line represents all readings from noon till 11 p.m. inclusive, and the dot-and-dash line all readings from midnight till 11 a.m. inclusive. The full line represents the readings for the 24 hours.

It should be noted that the shore of Lake Victoria Nyanza runs almost east–west in general direction near this point. In July the winds could well be due purely to diurnal changes in land and lake temperatures. In the case of October there seems to be a northerly wind superimposed on the on- and off-shore breezes, whilst in January the winds are predominantly south. But it should be observed in the latter case that the south winds blow much more strongly when reinforced apparently by the on-shore movement after midday.

The hour chosen to divide the day into two equal parts was that which by experiment gave the most striking contrast in directions. Thus for Zanzibar, it was more convenient to divide the day into the two parts, 3 a.m.–2 p.m. and 3 p.m.–2 a.m. Actually two unequal divisions would have shown an even clearer contrast, but the equal divisions were adhered to, for easier comparison with the other station.

The predominant wind in January in Chukwani is the north-east monsoon, and in July the south-east monsoon, both being, as would be expected, responsible for more air movement than anything at Kololo Hill. But the winds in a western quadrant at Chukwani appear in each case to be off-shore winds from the coast of Tanganyika, occurring entirely after midnight, and being deflected from their direct east–west course by the force of the monsoonal air movement.

The implications of these movements are interesting when studied in conjunction with the *Meteorological Office Geophysical Memoirs* No. 55, "A Study of the Atmospheric Circulation over Tropical Africa," by C. E. P. Brooks, D.Sc., and S. T. A. Mirrlees, M.A. The study, in connexion with which the diagrams were drawn, will be found in *Geography* for September, 1933, "An Outline of the Geography of Kenya," by Professor Rodwell Jones. The rainfall maps for the whole of British East Africa are in the hands of the Imperial Bureau of Soil Science.

F. H. W. GREEN.

Frequency Distribution of Sunshine at Newquay (Cornwall)

Dr. C. C. Vigurs, meteorological observer at Newquay, has prepared the analysis of the Newquay sunshine records shown in the table below. In this table the figures in Roman type show for each month the percentage frequency of occurrence of daily durations of sunshine between the limits given in the first column. We see, for example, that 6·7 per cent. of days in June yield a sunshine duration of 14·0 to 14·9 hours. The italic figures were obtained by successive summation of the Roman figures, beginning from the top of the column in each case, and they represent the percentage frequencies

Percentage Frequency and Accumulated Percentage Frequency of Days with Specified Duration of Sunshine at Newquay, Cornwall, 1893–1932

Duration.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Hours												
> 14·9	—	—	—	—	—	0·7	0·2	—	—	—	—	—
	—	—	—	—	—	*0·7*	*0·2*	—	—	—	—	—
14–14·9	—	—	—	0·1	2·9	6·7	4·0	0·1	—	—	—	—
	—	—	—	*0·1*	*2·9*	*7·4*	*4·2*	*0·1*	—	—	—	—
13–13·9	—	—	—	0·3	8·2	8·3	5·5	2·3	—	—	—	—
	—	—	—	*0·4*	*11·1*	*15·7*	*9·7*	*2·4*	—	—	—	—
12–12·9	—	—	—	5·6	8·1	7·2	6·5	6·3	0·7	—	—	—
	—	—	—	*6·0*	*19·2*	*22·9*	*16·2*	*8·7*	*0·7*	—	—	—
11–11·9	—	—	0·8	6·6	6·5	6·3	6·1	6·7	4·3	—	—	—
	—	—	*0·8*	*12·6*	*25·7*	*29·2*	*22·3*	*15·4*	*5·0*	—	—	—
10–10·9	—	—	3·7	8·9	5·6	6·5	7·3	9·0	8·3	0·4	—	—
	—	—	*4·5*	*21·5*	*31·3*	*35·7*	*29·7*	*24·4*	*13·3*	*0·4*	—	—
9– 9·9	—	0·7	7·7	7·6	6·6	6·4	6·2	8·1	10·2	3·9	—	—
	—	*0·7*	*12·2*	*29·1*	*37·9*	*42·1*	*35·9*	*32·5*	*23·5*	*4·3*	—	—
8– 8·9	0·1	4·9	7·9	7·7	6·5	5·7	5·9	7·7	6·8	6·8	1·6	—
	0·1	*5·6*	*20·1*	*36·8*	*44·4*	*47·8*	*41·8*	*40·2*	*30·3*	*11·1*	*1·6*	—
7– 7·9	2·2	8·0	8·1	7·3	6·8	5·4	6·3	6·9	7·7	8·0	6·0	0·2
	2·3	*13·6*	*28·2*	*44·1*	*51·2*	*53·2*	*48·1*	*47·1*	*38·0*	*19·1*	*7·6*	*0·2*
6– 6·9	5·0	7·0	6·9	5·9	5·2	6·1	4·4	7·1	6·6	8·8	6·7	3·4
	7·3	*20·6*	*35·1*	*50·0*	*56·4*	*59·3*	*52·5*	*54·2*	*44·6*	*27·9*	*14·3*	*3·6*
5– 5·9	5·3	5·8	8·6	6·2	5·8	4·8	7·8	5·6	7·4	8·6	9·0	4·8
	12·6	*26·4*	*43·7*	*56·2*	*62·2*	*64·1*	*60·3*	*59·8*	*52·0*	*36·5*	*23·3*	*8·4*
4– 4·9	7·4	8·0	8·1	6·1	5·5	4·9	4·7	6·2	7·2	8·8	6·6	6·9
	20·0	*34·4*	*51·8*	*62·3*	*67·7*	*69·0*	*65·0*	*66·0*	*59·2*	*45·3*	*29·9*	*15·3*
3– 3·9	7·8	6·7	7·6	7·0	5·4	5·1	6·1	5·2	6·5	7·4	7·8	8·7
	27·8	*41·1*	*59·4*	*69·3*	*73·1*	*74·1*	*71·1*	*71·2*	*65·7*	*52·7*	*37·7*	*24·0*
2– 2·9	8·6	7·9	8·3	6·6	5·5	4·7	5·7	5·8	5·7	8·6	9·2	10·5
	36·4	*49·0*	*67·7*	*75·9*	*78·6*	*78·8*	*76·8*	*77·0*	*71·4*	*61·3*	*46·9*	*34·5*
1– 1·9	10·7	9·7	7·2	5·7	5·0	6·1	5·8	6·6	7·5	8·6	10·0	10·8
	47·1	*58·7*	*74·9*	*81·6*	*83·6*	*84·9*	*82·6*	*83·6*	*78·9*	*69·9*	*56·9*	*45·3*
0·1– 0·9	16·6	13·7	9·6	9·6	7·3	8·3	9·9	8·7	9·5	11·5	15·4	17·8
	63·7	*72·4*	*84·5*	*91·2*	*90·9*	*93·2*	*92·5*	*92·3*	*88·4*	*81·4*	*72·3*	*63·1*
< 0·1	36·3	27·6	15·5	8·8	9·1	6·8	7·5	7·7	11·6	18·6	27·7	36·9
	100	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

of days yielding a sunshine duration not less than the lower limit in the first column. For example, we see that in June, 29·2 per cent. of the days have a sunshine duration not less than 11·0 hours; or in other words, 29·2 per cent. of June days yield 11·0 hours or more of sunshine.

The " class-interval " is one hour, except for the last two lines which show respectively the percentage frequencies of days with 0·1 to 0·9 hour, and no sunshine. The frequencies tabulated in Roman figures for these two groups should be added together to obtain the percentage frequencies for the complete interval 0·0 to 0·9 hour. When this is done it will be seen that in all months of the year the maximum frequency is represented by the interval 0·0 to 0·9 hour. In the winter months December and January more than half the days fall in this class. In June, however, only 15 per cent. of the days receive less than 1 hour of sunshine and only 6·8 per cent. have none at all.

The data here summarised show many points of interest. It will be noticed, for example, that in May and June the most frequent duration, next to 0·0–0·9 hour, is 13–13·9 hours. In winter months the percentage frequencies (Roman figures) increase steadily as you go down the table from top to bottom ; that is to say, the frequency decreases as the duration increases. For other months, however, there is comparatively little variation in frequency over a wide range of duration values. For example, in June, durations 1–1·9 hours, 6–6·9 hours, 11–11·9 hours and 14–14·9 hours are all about equally frequent. A similar feature has been noticed in the records from other stations which will form the subject of a forthcoming *Professional Note.* The mean daily duration of sunshine at Newquay varies from 1·6 hours in December to 7·2 hours in June. Dr. Vigurs' table shows that there is no tendency in any month for the mean duration to be associated with a maximum in the frequency curve.

A minor point of interest is that days with more than 6 hours of sunshine are rather more frequent in August than in July. The same remark applies to days with more than 1 hour, 2 hours, 3 hours and 4 hours, but not to days with more than 7, 8.....hours.

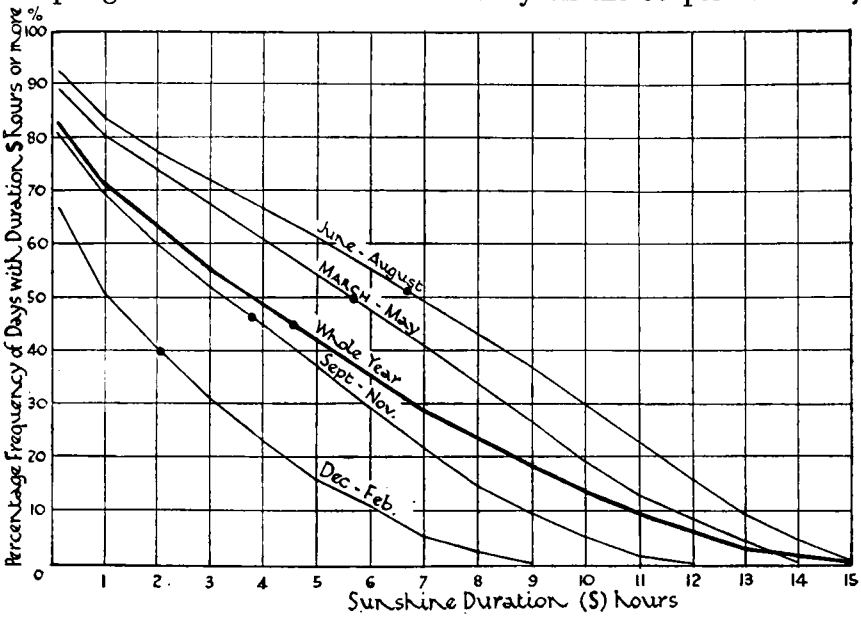
It is of interest to see how the total sunshine of a given month is distributed among days of different types. This has been done for the month of June with the results given below :—

Days	with	< 2·0	hours	contribute	2	per cent.	of	the	total.
,,	,,	2–4	,,	,,	4	,,	,,	,,	,,
,,	,,	4–6	,,	,,	7	,,	,,	,,	,,
,,	,,	6–8	,,	,,	11	,,	,,	,,	,,
,,	,,	8–10	,,	,,	15	,,	,,	,,	,,
,,	,,	10–12	,,	,,	19	,,	,,	,,	,,
,,	,,	12–14	,,	,,	27	,,	,,	,,	,,
,,	over	14	,,	,,	15	,,	,,	,,	,,

It will be seen that days with between 12 and 14 hours of sunshine contribute more than a quarter of the total duration. This is, of course, a direct consequence of the high frequency of such days at Newquay.

The diagram shows the values of the accumulated percentage frequencies for the whole year and for the four seasons. Values of the

mean daily duration are indicated by dots. It will be noticed that in spring and summer the dot lies nearly on the 50 per cent. line,



CURVES SHOWING THE PERCENTAGE FREQUENCY OF DAYS ON WHICH THE DURATION OF SUNSHINE EXCEEDS SPECIFIED VALUES (NEWQUAY 1893–1932).

indicating that durations above and below the mean are equally frequent. In winter, on the other hand, the dot lies on the 40 per cent. line, which means that in winter only 40 per cent. of the days give a sunshine duration exceeding the mean for the season.

E. G. BILHAM.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday evening, March 20th, at 49, Cromwell Road; Lt.-Col. E. Gold, D.S.O., F.R.S., President, in the Chair. As is customary in March, the meeting took the form of a lecture (The Symons Memorial Lecture), which was delivered on this occasion by Dr. F. J. W. Whipple, F.Inst.P., the subject being :—

The Propagation of Sound to Great Distances

It is well known that the sounds produced by explosions are sometimes heard at very great distances even when no sounds are to be heard at points comparatively close to the origin. This phenomenon has attracted the interest of meteorologists for a paradoxical reason —whilst the wind carries sound with it to moderate distances (and this is readily explained), the transmission to greater distances, 100 miles or more, seems to be independent of the weather. For closer investigation, microphones are used which record not only sounds which can be heard but also infrasonic waves which are too deep for perception by the human ear. By such means it is proved

that when sounds are heard at great distances the energy has traversed the atmosphere at levels far above the highest mountains. The maximum height of the path along which the energy travels is generally comparable with 25 miles. There is good evidence that at such a height the air is warmer than on the ground.

It was found during the war that the firing on the Western Front could be heard in this country only in summer and at like distances in Germany only in winter. This alternation, which is very consistent, is due to the change of the prevailing wind in the upper atmosphere. At a height of 12 miles the wind is generally from the east in summer, from the west in winter. How this reversal was connected with the great range of the changes of temperature in the course of the year in the upper atmosphere in Arctic regions was explained in the lecture.

No satisfactory explanation has yet been given of the high temperature which prevails in the upper atmosphere, apparently from pole to pole and at all seasons. There is much scope for further research.

Correspondence

To the Editor, *Meteorological Magazine*

Optical Phenomena of February 28th, 1935

On February 28th I observed one of the brilliant complex optical phenomena which are rare enough to warrant description. I was at Aston, Birmingham, and first saw it at 8h. 23m.

Brilliant parhelia of the 22° halo were shining, and through each ran a spectral band. Short fragments of parhelic circle began at the parhelia and stretched outwards for about 3°. They were colourless. A short, faint sun pillar showed above the sun. Short colourless pieces of the 22° halo were dimly visible near the parhelia. Finally, the circumzenithal arc was brilliant enough to attract the attention of ordinary pedestrians, who spoke of "a rainbow upside down." The length of the arc was about 90°.

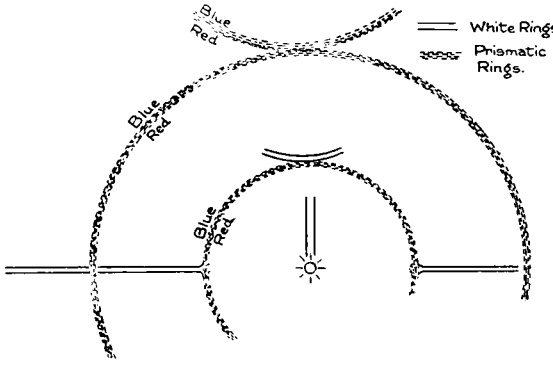
The weather at the time was fine. A gentle SW. wind was blowing light stratus across, otherwise no cloud was visible; I should have said, had there been no halos, that high cloud was quite absent. Near the parhelia, however, the illumination was enough to show faintly the high cloud with a little structure.

The display varied considerably. One component after another would vanish, and reappear. The only thing which persisted the whole time was the circumzenithal arc.

The sun pillar had disappeared by 8h. 25 m., and three minutes later the 46° halo appeared, faint and white. By 8h. 30m. it was complete and prismatic, but still faint. It had gone in another 3 minutes. An upper arc of contact of the 22° halo became visible at 8h. 35m. At 8h. 40m. the whole of the 22° halo, the upper arc

of contact, the two parhelia and the parhelic circle were bright. The last was visible only on the left-hand side, starting at the left parhelion and extending about 50° away from it. The left parhelion was particularly brilliant, almost as bright as the sun itself, shining as it was through the factory smoke usual in Aston at this time of day. The circumzenithal arc was just becoming fainter, and the structure of the high cloud distinguishable.

The figure includes all the components observed, whether they occurred simultaneously or not.



At 9h. 10m. I noticed the curious effect that neither the circumzenithal arc nor the arc of the 22° halo were touching their respective halos at the highest points (the 46° halo had reappeared). The point of contact in each case seemed to be slightly to the left of the point vertically above the sun. I feel that this was quite definitely the case, and not due to illusions caused by sloping buildings and like causes. On two other occasions recently observations of slanting upper arcs have been recorded.* I do not know the cause of the phenomenon, but I have no doubt about its reality.

The optical display commenced to fade by 10h. 15m., although the circumzenithal arc still remained coloured for some time after this. The system of ice crystals broke down gradually in normal fashion, leaving the most stable form at the end, which was still producing the 22° halo, but nothing else, at 11h. 10m.

From what has been said above, it appears that what we commonly call " circumzenithal arc " may have its centre somewhere other than at the zenith.

S. E. ASHMORE.

14, *Villa Road, Handsworth, Birmingham*, 19, *March 7th*, 1935.

I enclose a diagram of solar halos, which were observed here this morning (February 28th).

I noticed them for the first time at 8h. 25m. The left-hand parhelion was not yet visible, but the halos were quite distinct. The outer halo was, perhaps, a little more brightly coloured than the inner one. The arcs of contact were well defined. At 8h. 45m. the right-hand parhelion became very bright and slightly elongated to the right. The colour was yellowish white, with only a trace of prismatic shades. At about 9h. 20m. both parhelia were visible.

* A. E. MOON, *Meteorological Magazine*, 65, 1931, pp. 287–9 ; S. E. ASHMORE, *Meteorological Magazine*, 69, 1934, p. 216.

The outer halo had almost disappeared, but its upper arc of contact was extremely brilliant. The colours were as clear as those in a rainbow and the reds were on the side of the sun.

This was the most spectacular point of the display. A labourer exclaimed that he had never seen a halo " going that way before " The clouds at 8h. 25m. were, I think, cirrus and alto-stratus.

DONALD WATERER.

Whitfield Court, Knap Hill, Surrey, February 28th, 1935.

[Mr. Waterer's sketch (not reproduced) shows the halo of 22° with parhelia and arc of upper contact, the halo of 46° and its arc of upper contact, i.e. " the circumzenithal arc ". A small portion of the mock-sun ring is also shown extending from the right-hand parhelion away from the sun.

A number of other accounts of the halo phenomena seen on February 28th have been received. The circumzenithal arc was seen by Mr. M. A. Bolton at Oakamoor (North Staffordshire) from 13h. 45m. to 14h. 45m., and by Mr. J. Dover at Totland Bay (Isle of Wight) at 8h. 50m. A display including all the arcs seen by Mr. Waterer was observed at Felixstowe Aerodrome between 14h. 55m. and 15h. 55m. The observer writes: " The colours were exceptionally brilliant in this arc, (i.e. the circumzenithal arc), the blue was very pronounced and the violet quite noticeable ". Mr. M. W. Binns of Lutterworth (Leicestershire) observed a similar display from 9h. 45m., but the 46° halo itself is not shown in his sketch of the appearances. In addition, he observed a portion of the mock-sun ring extending from the left-hand parhelion.

Mr. A. O. Young, of Hazel Hurst, Kerne Bridge, Ross-on-Wye, sends an interesting account with two sketches. One of these, illustrating the appearance at 11h. 30m., shows an upper arc of contact, concave to the sun, similar to that illustrated in the upper photograph on Plate IV of the " Meteorological Observer's Handbook," 1934 edition (Aberdeen, May 27th, 1912).—E. G. BILHAM.]

Peculiar Phenomena on March 3rd, 1935

While almost every conceivable phenomenon in connexion with the passage of fronts has been noted upon by readers of the *Meteorological Magazine* in past issues, it appears that the extraordinary influence on visibility by these mystical divisions between air masses has not yet been sufficiently remarkable to warrant the attention of the readers. The events of Sunday, March 3rd, 1935, seem, however, to be of sufficient importance to permit the establishment of a precedent in this direction.

The day was marked in England by the passage of a front which showed peculiar characteristics. From dawn until noon the sky was partly covered by a very nondescript stratocumulus. Fog or mist was omnipresent, but never reduced visibility below 1,200 yds. At

12h. 30m. G.M.T. a thickening in the mist was observed. This continued until 15h. 15m., when a minimum of 250 yds. visibility was noted. The wind throughout had been south-easterly, force 1. The sky was by now obscured, but glimpses of an intense red sun through broken cloud moving from 300° could be noted.

By 16h. 15m. the day resembled a " London black-out ". Lights were necessary to read, even by a window, and cars were lit up. At 16h. 35m. heavy rain began with extreme suddenness, and continued for 7 minutes, giving a total fall of 0·10 in. At the onset of this rain the wind, which had dropped to a virtual calm, became a gentle breeze from NW., force 2. No squalliness was associated with this change. Temperature dropped 6° F., while the barometer continued uninterrupted a gentle rise.

The outstanding effect of the change of air conditions was, however, the banishment of the fog. At 16h. 45m. visibility had improved to 2,000 yds. and this subsequently improved steadily. Lights, etc., were rendered superfluous until the normal lighting up time of 17h. 50m.

These phenomena were, I believe, widespread.

F. K. HARE.

Wyleigh, Windsor Road, Slough, Bucks, March 25th, 1935.

[The phenomena referred to by Mr. Hare were also reported from south and west London, but did not extend north as far as Harrow or south as far as Malden, Surrey.—Ed. *M.M.*]

Thunderstorm Survey

The thunderstorm survey will be continued during the coming summer, when we shall again very greatly appreciate the privilege of the help of your readers in the observational work.

The main details required are the place, date and time of the occurrence, in any part of the British Isles, of thunder, lightning or hail, with the direction in which the lightning is seen, especially at night. The additional information desired is essentially the same as hitherto and is given fully in the *Meteorological Magazine,* for April, 1934.

The sections investigating lightning damage have, however, been extended recently and some fuller account of these may be of use.

Mr. Sidney T. E. Dark, B.Sc., 21, Fernwood Avenue, Streatham, S.W.16, is responsible for the section of trees struck by lightning. It is now possible to adopt a preliminary classification of types of damage and illustrated examples have been prepared. Mr. Dark will be glad to receive details of damaged trees, which should include a note of the kind of tree, its approximate height, the nature of the soil and subsoil, the nature and distance of the nearest water, and a note of the locality of the tree.

Reports of wireless aerials struck by lightning are collected by

Mr. R. A. Price, of 56, Ludgate Hill, E.C.4. He will appreciate such particulars as the supposed path of the discharge, how and to what the aerial was fixed, whether any switch or safety device was provided in the aerial circuit, and a note of the type of earthing employed.

General records of thunderstorms should be sent to the undersigned, from whom full details of the survey and postcards for observations may be obtained.

S. MORRIS BOWER.

Langley Terrace, Oakes, Huddersfield, March 27th, 1935.

NOTES AND QUERIES

Levanter Cloud at Gibraltar

A very good example of the Levanter cloud at Gibraltar is shown in the photograph forming the frontispiece to this number of the magazine, which was taken by the Royal Naval Photographic Section from a position 2½ miles south-east from Europa Point, on October 25th, 1934, at 7h. 30m. G.M.T. The weather map at 7h. G.M.T. that morning showed a large anticyclone centred over Russia and south-east Europe but also extending over the western Mediterranean and Spain, while a rather deep depression was centred off Ireland with a trough extending to between the Azores and Portugal. Over a considerable area around Gibraltar the gradient of pressure was slight. At 7h. the conditions indicated in the coded weather report from Gibraltar were wind SE., force 2; temperature, 64° F.; visibility, 6 to 12 miles; $\frac{4}{10}$ to $\frac{6}{10}$ of stratocumulus or stratus cloud with its base at 1,000–2,000 ft. This cloud report accords with the observation which an observer immediately beneath the Levanter cloud might be expected to make. By 13h. the wind had veered to E. and increased to force 3.

In the photograph three distinct layers of cloud are shown, not directly superposed but progressing northwards, and the cumulus hump, which forms a feature of these clouds, is seen well formed before breaking away to move down wind. An account of the formation of the Levanter cloud is to be found in *Geophysical Memoirs No.* 59: "A survey of the air currents in the Bay of Gibraltar, 1929–30", by J. H. Field, C.S.I., M.A., and R. Warden, Ph.D. (M.O. 356b).

Wind Pressure on Buildings

In the October issue of this magazine, Mr. C. S. Durst draws attention to a recent paper which gives information on the distribution of pressure observed on the gabled roof of a shed lying across a wind. The suction effect on the lee slope of the roof is greater, while that just behind the windward eaves is less, than would be expected from experiments with a model in a wind-tunnel. It is well known that the model experiment is not simply the natural experiment on

a small scale. Suppose in the model the scale of length is reduced in the ratio 1 : 30. The wind speed, pressure (static) and viscosity, all of which have a power of the length as one of their dimensions, are, however, left unaltered in the model experiment. Nevertheless it had been assumed in the past that ratios of the pressures at two points, not being dependent on the scale of length, would be the same in the two experiments. Recent investigations have shown that this is not so.

The assumption tacitly assumes that the air stream in the natural wind is of the same type as that in the tunnel. When the wind meets a building in its path, the deformation it undergoes in order to circumvent the obstacle may consist of either a relatively smooth stream-line motion, or an irregular turbulent motion. The possibility that the motion in the natural wind is unstable, while that in the wind tunnel is more nearly stream-lined is suggested by a consideration of the Reynolds number in the two cases. This is given by Vl/ν, where V is the wind speed, l the linear dimension, and ν the kinematic viscosity. As V and ν are the same in both cases, the Reynolds number in the wind tunnel is $\frac{1}{30}$ of that in the natural wind. The critical values may not be the same, but the large difference in the two numbers supports the suggestion that the two motions are far from being dynamically similar. If this is the case, it would provide a qualitative explanation of the different distributions of pressure, while the difference between the structure of the free wind in nature and in the tunnel would be of only secondary importance.

In regard to the destructive effect of tornadoes, it can hardly be doubted that the quasi-explosive action contributes to the damage (W. G. Kendrew in "Climate," p. 274, mentions that in a tornado "bottles are uncorked"), but this effect would be greatest on a wall or roof subject to the additional effect due to the wind alone; hence the reason why sometimes a wall on the lee side of a building falls outwards while the other walls remain standing, although it appears that in some cases the explosive effect is sufficient to blow all the walls outwards. The curious fact stands out that a person wishing to shelter from a tornado had better stand on the exposed side of a building than against the "sheltered" side.

A. F. CROSSLEY.

Irish Bog Flow

A cutting from the *Irish Times* of October 29th, kindly sent by Lieut.-Col. W. A. Bentley, of Hurdlestown, Broadford, Co. Clare, describes the bursting of a large bog, 20 acres in extent, at Maghera, Co. Clare. The bog has always been "trembling," and as a result of heavy rain in October—Col. Bentley recorded 1·05 in. on the 24th—it began to move down the mountain side early on the 25th,

with a deep rumbling noise. It spread out in the valley below, inundating fields and crops over an area of about six square miles, and making several roads impassible for traffic. The bog travelled about four miles, along a front of about 150 yards, before it came to rest, and its passage was irresistible. Similar flows have occurred from time to time in other bogs and Col. Bentley recalls one which took place about 30 years ago near Lindonvarna in Co. Clare.

They occur in high bogs on mountain tops in an oceanic climate, where according to E. Granlund* conditions are especially favourable for the growth of bogs, which can grow to an almost indefinite height and develop an unnaturally steep margin, so that sooner or later, the lateral pressure becomes greater than the surface tension. Thus a bog outbreak is a quite natural development, though its actual occurrence may be the result of special conditions, such as a period of heavy rainfall. Outbreaks have been known to occur in many places in the west, centre and north of Ireland, but not in the east.

REVIEWS

World Weather and Solar Activity. By H. Helm Clayton, Washington, D.C., Smiths Misc. Coll. Vol. 89, No. 15, 1934. pp. 1–52.

For a number of years Mr. Clayton has been painstakingly working out the relations between variations of solar radiation and changes of terrestrial weather. The general result has been that the association between solar and terrestrial conditions is most definite in certain "centres of action," but that the latter are not fixed in space. In this paper he works out the beginnings of a mechanism of the relationship. The most active regions are in tropical regions where the water vapour content of the atmosphere is high. Here pressure tends to be low when solar radiation is high, and it is suggested that the fall of pressure is due to the absorption of radiation by the water vapour causing a rise of temperature and a decrease of density. The resultant fall of pressure is compensated by a rise in higher latitudes: if the solar radiation is especially high, the fall of pressure extends into regions further from the equator, and the rise is pushed into very high latitudes.

The correlation coefficients listed on p. 24 are obscure. It appears that the annual values of solar radiation were divided into six groups ranging from very high to very low. The mean departures of pressure for seasons falling into each group were then found for each of a number of stations, and the mean departures for very high and very low radiation were correlated, also those for moderately high and low radiation and slightly high and low radiation, for the northern and southern hemispheres separately. Five of the six coefficients are negative, the mean value being $-\cdot32$. A little consideration shows, however, that since at any station the sum of all the deviations

*Die Geologie der schwedischen Hochmoore. *Stockholm, Sverig. geol. Unders. Afh.*, 26, 1932, No. 1.

must be zero, if the mean deviation at any station for any one radiation group is positive, the odds are that the mean deviation at that station for any other radiation group will be negative. Hence negative coefficients of about the amount found would be expected irrespective of whether any real relationship existed. If only two radiation groups had been made instead of six, the correlation would necessarily have been — 1.

There is a curious slip on p. 23, where it is stated that an increase of radiation by 1 per cent. would be balanced by " an increase of ·01 per cent. in cloudiness." The figure should of course be 1 per cent. But these slips are merely incidental, and do not detract from the interest of the paper as a whole.

C. E. P. BROOKS.

Subsidence Within the Atmosphere. By Jerome Namias. Harvard Meteorological Studies No. 2. Cambridge, Mass., Harvard Univ. Press, 1934.

The author gives a simple and lucid general account of subsidence and associated problems, followed by a detailed aerological analysis of three periods (in October, March and December), during which subsidence took place in America. Observations of upper air temperature and humidity were available from 14 stations in the United States, covering a very much larger area than the European network. This paper brings out the importance of a good network and a large area for this type of investigation. The analysed synoptic charts and a large mass of upper air data are clearly and conveniently set out.

The problem investigated is the subsidence and lateral divergence of a cold air mass, associated with the " isallobaric high " in front of a moving anticyclone. The subsidence inversion, or " surface of subsidence " is developed within the subsiding air mass, and is found to assume the form of a dome. On one occasion (p. 43) the discontinuity appeared first at a height of 3·6 Km., and next day was probably nowhere higher than 2·1 Km., while the area covered by the cold air had greatly increased. Subsequently the inversion descended in places to quite low levels, joining with the surface radiation inversion. On another occasion (p. 19) a subsidence of about 1 Km. per day was obtained.

Margules* showed that when a slab of air subsides the expression $(\alpha + \gamma)/pq$ remains constant, where p is the pressure, q the cross-section of the slab, and $\alpha + \gamma$ is the difference between the actual lapse-rate and the adiabatic rate. It is impossible to observe the changes of q without a close network of really accurate upper wind observations, but the other variables can be measured, and the changes of q deduced from them. By this method, Namias proves the existence of divergence at the 3-Km. level. It is clear from the formula that subsidence normally reduces the lapse-rate and intensifies an ordinary

* *Met. Zs. Braunschweig.*, 1906, p. 241.

discontinuity with the smaller lapse-rate above it. The main difficulty is to account for the initial discontinuity high up in the polar air, from which the main inversion subsequently develops as the air descends. Over the oceans there is convectional cloud up to a considerable height in the early stages of subsidence, and it is not difficult to envisage the formation of a well-defined upper limit to the convection and cloud. But in America in winter the lower strata are normally stable, and turbulence from the ground cannot penetrate beyond a shallow layer. The author suggests radiation from a layer of haze as a possible cause, but it is difficult to account for the haze.

Another unsolved problem is that of down-sliding on the surface of subsidence. The author argues in favour of this, on the ground that the potential temperature at the top of the inversion sometimes rose as the inversion descended. His actual figures show that in these cases absolute humidity also rose, suggesting that the air mass was not originally homogeneous. In order to obtain real proof of down-sliding, one would need to follow up the motion of relatively small air masses by means of upper wind observations. No doubt the available data are inadequate for this, but the paper would have been improved if more upper wind observations had been published. In ordinary anticyclones it is very difficult to explain genuine-down-sliding, as distinct from a general sinking of the entire air mass, with a vertical motion increasing *continuously* up to 3 or 4 Km. A sloping inversion cuts a horizontal surface (say at 1 or 2 Km.) at a sharp front, and the main wind discontinuity is parallel to the front, and has no effect on the vertical motion. If the wind is geostrophic, the difference of density results in a slight down-sliding at a cold front, but this effect is very small. If the down-sliding is large enough to be of any practical importance, there must be an appreciable diverging non-geostrophic wind component at the front. This need only be small in relation to the geostrophic wind, but dynamically it is important, and no adequate explanation of such divergence at an anticyclonic inversion has ever been offered. A study of the isallobars indicates a general divergence, both below and above the discontinuity, and near the ground friction adds to the divergence of the lower strata—an effect opposed to down-sliding up above, since the latter involves an abrupt increase of downward motion above the inversion, usually a kilometre or more above the ground.

Namias has made a real contribution to our knowledge of the subject, but there is still much to be explained.

C. K. M. DOUGLAS.

The upper winds of Hong Kong from observations made with pilot balloons, 1921–1932. By G. S. P. Heywood, B.A., B.Sc. Size 12 in. × 8¼ in., pp. 13 + 9 plates. Hong Kong, 1933.

This pamphlet summarises in two tables and nine diagrams the results of 1,382 pilot balloon ascents made during the period June,

1921 to December, 1932 at Hong Kong. These results are set out in a very convenient form, and the discussion of the upper air structure at Hong Kong, which precedes the tables and diagrams, is clear and concise.

This upper air structure is interesting as in the winter, when the north-east monsoon is blowing, the prevailing winds near the surface are from ENE, whilst at a height varying between 5,000 and 10,000 feet there is a reversal of wind direction, and above this level strong westerly winds prevail. In the summer, on the other hand, the upper winds are easterly, whilst the surface winds, although much more variable than in the winter, are mainly southerly. There is little doubt that this marked difference between the upper air structure of winter and that of summer is largely due to the north and south movements of the equatorial belt of easterly upper winds, which in the winter lies to the southward of the latitude of Hong Kong (22° 18′ N), but which moves north throughout the spring, and south during the autumn. From June to September Hong Kong is within this belt, whilst during the remaining months of the year it is in the region of westerly upper winds which lies to the northward of the equatorial belt.

A table is given showing the individual results of every pilot balloon ascent made when the centre of a typhoon was within 1,000 miles of Hong Kong. The observations are mostly confined to the north-west and south-west quadrants of typhoons, and naturally very few flights could be carried out when a typhoon was within two or three hundred miles of Hong Kong. It is a pity that this table was not arranged so that the reader could tell at a glance the relative position of the typhoon at the time of any particular set of observations, or alternatively the data in this table might with advantage have been put into diagrammatic form.

It is to be hoped that some reliable method of forecasting the movements of typhoons will emerge as a result of the gradual accumulation of upper air observations in the vicinity of these storms, and in this connexion it is interesting to note that the forecasters at the Hong Kong Observatory have always held that an upper westerly wind precludes the possibility of a typhoon approaching the colony from the eastward (the usual direction from which these storms approach), and this precept appears to be correct.

A. E. M. DODINGTON.

India Meteorological Department, Memoirs, Vol. XXVI, Part I—Registration of earth current with neutral electrodes. By S. K. Banerji, D.Sc.

A method of recording earth current with short lines is described which is free from complications due to large polarisation current, the chief drawback to short line registration. Typical records are reproduced of earth current at Colaba and Alibag, distant respectively

5 and 25 miles from the centre of Bombay. The natural earth current at Colaba is swamped by artificial disturbances due to leakage from the electric tramway system in Bombay; a record of the fluctuation in voltage at the Bombay power station is included for comparison. The declination magnetogram also shows disturbance during the period when the fluctuation in voltage is considerable. From records at Alibag, where the artificial disturbance is much smaller, the diurnal variation of earth current is deduced and curves showing the mean diurnal variation for the year and for the winter season separately are compared with similar curves of atmospheric potential gradient and of magnetic force. Finally, the earth current record and the magnetograms at Alibag on a day of magnetic disturbance are reproduced and compared in detail. The paper is clear and concise and touches briefly on the chief points which arise in the study of earth currents.

H. L. WRIGHT.

BOOKS RECEIVED

On the nature of the frequency distribution of precipitation in India during the monsoon months, June to September. By D. Sankaranarayanan. India Meteor. Dept., Sci. Notes, Vol. V, No. 55.

OBITUARY

We regret to learn of the death on March 2nd of Dr. Karl Langer, who maintained a climatological station at Bucklebury Place, Woolhampton, Berks, from 1905 to 1929.

We regret to learn of the death on March 19th, 1935, in his 35th year, of Mr. S. N. Plummer, Grade II Clerk in the Meteorological Office. Mr. Plummer served in the R.N.A.S. and R.A.F. from 1917–9; he entered the Office in January, 1920, and has worked mostly at Distributive Stations.

The Weather of March, 1935

Pressure was above normal over Europe and the Mediterranean, north and east Iceland, Spitsbergen, Alaska, northern Canada, eastern United States and Bermuda, the greatest excess being 11·1 mb. at Röst (Norway) and 4·0 mb. off Nantucket U.S.A. Pressure was below normal over southern Canada, most of the United States and the North Atlantic and also western Siberia, the greatest deficits being 5·8 mb. near Manitoba and 5·4 mb. at 50° N., 30° W. Temperature was above normal in Spitsbergen and generally in Scandinavia, but below normal in central and south-west Europe while rainfall was in excess in northern Norway and Svealand, but deficient elsewhere in Sweden and in central Europe.

The outstanding feature of the weather of the month over

the British Isles was the deficiency of rainfall especially in the south-east, where at a few places absolute droughts occurred between about the 4th and 22nd. A cold spell was experienced on the 8th to 11th and on the 14th, while temperature was considerably above normal from the 16th to 28th. From the 1st to 3rd low pressure extended from Greenland to central Europe giving generally unsettled conditions, while gales were experienced in north Scotland and on the 2nd in south-west England as well. Snow was reported on the hills in Scotland and Wales and local mist or fog in England. After the 3rd the high-pressure area over the Azores extending north-east, joined with the high-pressure area over Scandinavia and gradually anticyclonic conditions spread from the south over the whole country. Gales with local hail and snow occurred at times in the extreme north and a thunderstorm was reported from Oban on the 5th. Elsewhere there was slight rain but many bright intervals; Harrogate had 9·8 hours bright sunshine on the 4th. On the 7th mist or fog occurred generally. From the 7th to 14th an anticyclone was centred over Scandinavia and very cold easterly winds prevailed in the south with snow at most places in the Channel Islands and England as far north as York and Southport. Further north the winds were mainly SE. to S. and the weather fair and milder; 10·6 hours bright sunshine were recorded at Oban on the 14th. Maximum temperatures in the south did not rise above 32° F. at Jersey and Tunbridge Wells on the 9th, and at many places in the south did not exceed 35° F. both then and on the 10th. The 12th and 13th were milder with much sun—10·4 hours at Lowestoft and Oxford on the 12th, but on the 14th there was a renewal of cloudy, cold conditions in the south. A depression passed eastwards across the country from the 15th to 17th and from then to the 26th pressure was low to the west and north and high to the south. Weather was unsettled in the north and west and mainly fair in the south with slight rain at times from the 16th to 21st, but heavier rain generally from then to the 26th—1·33 in. fell at Snowdon and 1·16 in. at Lake Vyrnwg (Montgomery) on the 23rd. Strong westerly winds reaching gale force at times were experienced in the south-west and west on the 23rd and again in the north and west on the 25th and 26th. Local mist or fog occurred frequently in England. Temperature was considerably above the normal during this time and rose above 65° F. at several places on the 20th and 21st—68° F. was recorded at S. Farnborough on the 20th and at Cromer on the 21st. These two days were also the sunniest—Manston (Kent) had 11·2 hours on the 21st. On the 26th the anticyclone to the south spread over the whole country and remained until the 30th and 31st, when the north and west came under the influence of another depression. The 27th and 28th were warm sunny days generally though thick fog occurred in the English Channel, but on the 29th the northerly wind current brought cooler weather with rain or drizzle in the east and cloudier conditions in the west. The 30th

was a dull day and by the 31st strong winds rising to gale force were reported in the north in the evening. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	150	+45	Liverpool ...	102	− 2
Aberdeen ...	101	− 6	Ross-on-Wye ...	133	+25
Dublin	114	− 3	Falmouth ...	107	−28
Birr Castle ...	121	+11	Gorleston ...	140	+17
Valentia... ...	100	−15	Kew	109	+ 6

Miscellaneous notes on weather abroad culled from various sources

The Douro river was in flood on the 1st. Severe cold was again experienced in Switzerland after the 6th and snow fell in abundance on the 7th even in the low country, making ski-ing conditions good. Owing to a strong easterly gale and heavy seas, steamship communication between Spain and Africa was suspended about the 8th. A sudden cold spell occurred in Italy from about the 8th to 10th and snow fell in Naples and the surrounding country, and also in Abruzzi and many districts of Apulia as far south as Taranto on the night of the 8th–9th. Snowstorms and bad weather occurred in southern France, expecially the south-east on the 12th ; parts of the railway lines between Lyons and Nîmes were blocked by snow-drifts. Strong winds were experienced in the Austrian mountains from about the 10th–12th. By the 11th navigation was entirely free at Constanza. Red snow is reported to have fallen and laid nearly 1 in. deep at Kars (Transcaucasia) on the 22nd. On the 30th and 31st gales occurred in the Adriatic and five trawlers were sunk ; much destruction was also done in the Lake Garda region, while snow fell along the Tuscan Apennines (*The Times*, March 2nd–April 1st).

A heat wave was experienced in Bombay between the 8th and 11th, temperature reaching 100° F., while the humidity was much below the average. A severe sandstorm swept across Baghdad on the night of the 30th–31st and a 60 m.p.h. wind caused severe damage to the Kotah pontoon bridge (*The Times*, March 11th–April 1st).

Fewer bush fires than usual had been experienced in South Australia up to the 11th, although the dry spell was reaching record length. Heavy rain fell during the month in Victoria, New South Wales, the Northern Territory and parts of Western Australia, and light to moderate rain elsewhere in Western Australia and in New Zealand, while drought conditions prevailed generally in Queensland. A severe storm occurred off the north-west coasts of Western Australia on the 26th; at Broome some houses collapsed (*The Times*, March 11th–29th).

A severe thunderstorm was experienced over St. John's, Newfoundland, on the 4th. The flooded tributaries of the Mississippi were still rising on the 14th and floods were reported from Missouri,

southern Illinois and north-east Arkansas. Dust storms in the Middle Western States caused 19 deaths during the last fortnight of the month, besides much material damage, especially in western Kansas, eastern Colorado and parts of Wyoming. Temperature in the United States was very variable and unusually high readings were obtained during two warm spells in the fortnight ending the 26th. Precipitation was generally below normal except in some of the Gulf States, where the rainfall was heavy for the week ending the 12th (*The Times*, March 6th–28th, and *Washington D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin*).

Daily Readings at Kew Observatory, March, 1935

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	Remarks. (see p. 1).
	mb.		°F	°F	%	in.	hrs.	
1	992·9	SW.2	37	47	70	0·01	3·1	r–r_0 1h.–2h.
2	1010·8	NNW.3	38	48	74	trace	0·1	m 7h. & 18h., r_0 21h.
3	1016·5	ENE.2	41	47	85	0·13	0·0	f 13h., r_0–R 16h.–23h.
4	1027·4	WNW.2	36	49	57	—	8·3	m 18h.–21h.
5	1028·8	WSW.3	32	51	44	trace	3·5	r_0 15h. & 16h. 10m.
6	1031·2	N.3	40	47	71	0·03	0·1	r_0 7h.–9h. 40m.
7	1036·4	NE.2	41	48	50	—	4·7	m 18h.–21h.
8	1038·1	ENE.4	35	38	58	trace	0·1	ps_0 21h. & 22h.
9	1032·0	ENE.7	30	35	53	trace	0·2	s_0 9h. & 17h.
10	1023·5	ENE.5	32	37	65	trace	0·2	s_0 23h. 50m.
11	1028·7	ENE.5	36	40	58	trace	3·0	s_0 early.
12	1033·2	NE.3	33	51	26	—	9·1	x early, z 9h.
13	1026·2	NE.4	34	49	57	—	5·6	z 9h. & 18h.–21h.
14	1017·5	N.2	35	41	81	—	0·0	m 0h.–17h, f 18h.
15	1012·5	S.2	38	51	57	—	5·3	f 18h, z 21h.
16	1000·0	SSE.2	38	56	64	0·01	0·1	f 0h.–10h., r_0 19h.
17	1006·8	N.1	45	54	72	trace	0·1	f 10h., r_0 14h. & 15h.
18	1019·4	W.2	40	55	74	—	5·9	f 0h.–8h.
19	1018·3	S.3	35	59	58	—	9·0	fx early.
20	1015·0	SSW.2	40	63	54	—	7·4	fw early.
21	1016·3	SW.3	38	63	56	trace	10·4	fx early, pr_0 22h.
22	1011·9	SW.4	47	55	79	0·02	1·3	$r_0$11h.,13h.,18h.&20h.
23	1013·4	SW.4	44	53	86	0·17	0·4	rr_0 11h.–18h.
24	1023·7	WNW.3	47	60	52	trace	8·4	d_0 23h.
25	1027·2	WSW.3	49	55	65	trace	0·8	d_0 0h.–0h. 15m.
26	1027·5	SW.3	40	58	79	—	2·4	w early.
27	1028·7	NNW.2	41	56	53	—	8·7	w early.
28	1029·0	W.3	39	59	58	—	6·4	fw early.
29	1028·8	N.4	44	52	59	—	1·5	w early.
30	1027·3	SW.3	40	47	67	—	0·0	
31	1017·1	W.3	43	57	62	—	3·4	
*	1021·5	—	39	51	63	0·37	3·5	* Means or totals.

General Rainfall for March, 1935.

England and Wales ...	38	per cent. of the average 1881–1915.
Scotland	71	
Ireland	53	
British Isles	49	

Rainfall : March, 1935 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square.....	·37	20	*Leics* .	Thornton Reservoir ...	·78	42
Sur .	Reigate, Wray Pk. Rd..	·63	27	,, .	Belvoir Castle.....	·78	43
Kent .	Tenterden, Ashenden...	·28	13	*Rut* .	Ridlington	·70	40
,, .	Folkestone, Boro. San.	·28	...	*Lincs* .	Boston, Skirbeck.....	·37	24
,, .	Eden'bdg., Falconhurst	·44	18	,, .	Cranwell Aerodrome...	·45	32
,, .	Sevenoaks, Speldhurst.	·46	...	,, .	Skegness, Marine Gdns.	·37	22
Sus .	Compton, Compton Ho.	1·01	36	,, .	Louth, Westgate.....	·51	24
,, .	Patching Farm.....	·60	28	,, .	Brigg, Wrawby St.....	·42	...
,, .	Eastbourne, Wil. Sq....	·67	30	*Notts* .	Worksop, Hodsock.....	·66	39
,, .	Heathfield, Barklye....	·94	38	*Derby*.	Derby, L. M. & S. Rly.	·69	40
Hants.	Ventnor, Roy.Nat.Hos.	1·48	72	,, .	Buxton, Terr. Slopes...	2·02	49
,, .	Fordingbridge, Oaklnds	·94	40	*Ches* .	Runcorn, Weston Pt....	1·00	50
,, .	Ovington Rectory.....	·91	35	*Lancs*.	Manchester, Whit. Pk.	1·22	54
,, .	Sherborne St. John.....	·58	26	,, .	Stonyhurst College.....	1·50	41
Herts .	Royston, Therfield Rec.	.58	32	,, .	Southport, Bedford Pk.	·97	44
Bucks.	Slough, Upton.....	·54	31	,, .	Lancaster, Greg Obsy.	1·46	46
,, .	H. Wycombe, Flackwell	·66	33	*Yorks*.	Wath-upon-Dearne.....	1·30	75
Oxf .	Oxford, Mag. College...	·46	30	,, .	Wakefield,Clarence Pk.	·85	47
Nor .	Wellingboro, Swanspool	·46	26	,, .	Oughtershaw Hall.....	2·04	...
,, .	Oundle	·46	...	,, .	Wetherby, Ribston H..	·81	42
Beds .	Woburn, Exptl. Farm...	·41	24	,, .	Hull, Pearson Park.....	·66	36
Cam .	Cambridge, Bot. Gdns.	.30	20	,, .	Holme-on-Spalding.....	·85	47
Essex.	Chelmsford, County Lab	·76	44	,, .	West Witton, Ivy Ho.	·90	29
,, .	Lexden Hill House.....	·55	...	,, .	Felixkirk, Mt. St. John.	·85	43
Suff .	Haughley House.....	·80	...	,, .	York, Museum Gdns....	·77	46
,, .	Campsea Ashe.....	·67	40	,, .	Pickering, Hungate.....	·84	42
,, .	Lowestoft Sec. School...	·69	43	,, .	Scarborough.....	·62	34
,, .	Bury St. Ed., WestleyH.	·79	42	,, .	Middlesbrough.....	·53	34
Norf. .	Wells, Holkham Hall...	·36	22	,, .	Baldersdale, Hury Res.	1·68	54
Wilts .	Calne, Castleway.....	·72	34	*Durh* .	Ushaw College.....	·79	36
,, .	Porton, W.D. Exp'l. Stn	·81	41	*Nor* .	Newcastle, Town Moor.	·50	24
Dor .	Evershot, Melbury Ho.	1·19	40	,, .	Bellingham, Highgreen	1·11	38
,, .	Weymouth, Westham.	1·10	53	,, .	Lilburn Tower Gdns....	1·46	55
,, .	Shaftesbury,Abbey Ho.	1·33	57	*Cumb*.	Carlisle, Scaleby Hall...	1·32	54
Devon.	Plymouth, The Hoe....	1·11	38	,, .	Borrowdale, Seathwaite	...	...
,, .	Holne, Church Pk. Cott.	2·06	38	,, .	Borrowdale, Moraine...	2·61	31
,, .	Teignmouth, Den Gdns.	1·37	53	,, .	Keswick, High Hill.....	1·15	26
,, .	Cullompton	1·30	47	*West* .	Appleby, Castle Bank...	1·32	49
,, .	Sidmouth, U.D.C.....	1·27	...	*Mon* .	Abergavenny, Larchf'd	·78	26
,, .	Barnstaple, N. Dev.Ath	1·27	48	*Glam* .	Ystalyfera, Wern Ho....	1·55	29
,, .	Dartm'r,Cranmere Pool	2·30	...	,, .	Cardiff, Ely P. Stn.....	1·09	34
,, .	Okehampton, Uplands.	2·11	51	,, .	Treherbert, Tynywaun.	2·21	...
Corn .	Redruth, Trewirgie.....	·96	27	*Carm* .	Carmarthen, Priory St..	1·00	26
,, .	Penzance, Morrab Gdn.	1·18	37	*Pemb* .	Haverfordwest,Portfld.	...	...
,, .	St. Austell, Trevarna...	1·57	46	*Card* .	Aberystwyth	1·59	...
Soms .	Chewton Mendip.....	1·33	37	*Rad* .	BirmW.W.Tyrmynydd	2·28	42
,, .	Long Ashton.....	·68	27	*Mont* .	Lake Vyrnwy	2·13	50
,, .	Street, Millfield.....	·98	48	*Flint* .	Sealand Aerodrome.....	·80	45
Glos .	Blockley	·39	...	*Mer* .	Dolgelley, Bontddu.....	2·20	45
,, .	Cirencester, Gwynfa....	·50	22	*Carn* ·	Llandudno	·69	34
Here .	Ross, Birchlea.....	·50	25	,, .	Snowdon, L. Llydaw 9..	5·48	...
Salop.	Church Stretton.....	1·14	48	*Ang* .	Holyhead, Salt Island...	·91	35
,, .	Shifnal, Hatton Grange	·87	47	,, .	Lligwy	...	...
Staffs .	Market Drayt'n, Old Sp.	·57	27	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	·50	29		Douglas, Boro' Cem....	1·56	53
War .	Alcester, Ragley Hall...	·60	35	*Guernsey*			
,, .	Birminghm, Edgbaston	·64	34		St. PeterP't.Grange Rd.	1·54	62

Rainfall: March, 1935: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig .	Pt. William, Monreith.	1·25	44	*Suth* .	Melvich.....	3·16	111
,, .	New Luce School.....	1·83	52	,, .	Loch More, Achfary....	7·94	123
Kirk .	Dalry, Glendarroch.....	1·67	37	*Caith* .	Wick.....	1·93	85
,, .	Carsphairn, Shiel.....	2·44	40	*Ork* .	Deerness	2·77	99
Dumf.	Dumfries, Crichton, R.I.	1·04	37	*Shet* .	Lerwick	3·65	116
,, .	Eskdalemuir Obs.....	2·58	53	*Cork* .	Caheragh Rectory.....	2·11	...
Roxb .	Branxholm.....	1·21	42	,, .	Dunmanway Rectory...	2·15	44
Selk .	Ettrick Manse.....	2·08	41	,, .	Cork, University Coll...	1·54	51
Peeb .	West Linton.....	1·56	...	,, .	Ballinacurra.....	1·65	58
Berw .	Marchmont House.....	1·51	57	,, .	Mallow, Longueville....	1·61	56
E.Lot .	North Berwick Res.....	1·42	76	*Kerry* .	Valentia Obsy.....	2·17	48
Midl .	Edinburgh, Roy. Obs..	·91	46	,, .	Gearhameen.....	3·40	42
Lan .	Auchtyfardle	1·62	...	,, .	Darrynane Abbey.....	1·80	44
Ayr .	Kilmarnock, Kay Pk....	2·56	...	*Wat* .	Waterford, Gortmore...	1·55	57
,, .	Girvan, Pinmore.....	1·85	49	*Tip* .	Nenagh, Cas. Lough....	2·11	68
Renf .	Glasgow, Queen's Pk....	1·75	67	,, .	Roscrea, Timoney Park	2·17	...
,, .	Greenock, Prospect H..	2·12	43	,, .	Cashel, Ballinamona....	1·86	68
Bute .	Rothesay, Ardencraig...	2·29	...	*Lim* .	Foynes, Coolnanes.....	2·50	85
,, .	Dougarie Lodge.....	1·70	...	,, .	Castleconnel Rec.....	2·83	...
Arg .	Ardgour House.....	6·89	...	*Clare* .	Inagh, Mount Callan....	3·94	...
,, .	Glen Etive.....	6·07	77	,, .	Broadford, Hurdlest'n.	2·12	...
,, .	Oban.....	3·19	...	*Wexf* .	Gorey, Courtown Ho...	1·16	50
,, .	Poltalloch.....	3·50	92	*Wick* .	Rathnew, Clonmannon.	·96	...
,, .	Inveraray Castle.....	4·87	77	*Carl* .	Hacketstown Rectory...	1·39	50
,, .	Islay, Eallabus.....	1·94	51	*Leix* .	Blandsfort House.....	1·72	66
,, .	Mull, Benmore.....	10·40	98	,, .	Mountmellick	...	...
,, .	Tiree.....	2·22	66	*Offaly* .	Birr Castle.....	1·36	57
Kinr .	Loch Leven Sluice.....	1·02	34	*Dublin*	Dublin, FitzWm. Sq....	·51	26
Perth .	Loch Dhu.....	3·20	49	,, .	Balbriggan, Ardgillan...	·77	38
,, .	Balquhidder, Stronvar.	2·72	...	*Meath.*	Beauparc, St. Cloud....	·99	...
,, .	Crieff, Strathearn Hyd.	1·62	51	,, .	Kells, Headfort.....	1·18	43
,, .	Blair Castle Gardens....	2·14	82	*W.M* .	Moate, Coolatore.....	1·68	...
Angus.	Kettins School.....	1·37	56	,, .	Mullingar, Belvedere...	2·07	77
,, .	Pearsie House.....	2·14	...	*Long* .	Castle Forbes Gdns.....	2·06	70
,, .	Montrose, Sunnyside...	1·94	93	*Gal* .	Galway, Grammar Sch.	2·86	...
Aber .	Braemar, Bank.....	1·54	52	,, .	Ballynahinch Castle....	2·46	48
,, .	Logie Coldstone Sch....	1·29	50	,, .	Ahascragh, Clonbrock.	2·36	71
,, .	Aberdeen, King's Coll..	2·06	85	*Mayo.*	Blacksod Point.....	2·13	52
,, .	Fyvie Castle.....	1·40	51	,, .	Mallaranny	2·99	...
Moray	Gordon Castle.....	2·00	86	,, .	Westport House.....	2·05	53
,, .	Grantown-on-Spey	1·53	58	,, .	Delphi Lodge.....	3·38	41
Nairn.	Nairn	1·37	73	*Sligo* .	Markree Obsy.....	2·16	64
Inv's .	Ben Alder Lodge.....	3·26	...	*Cavan.*	Crossdoney, Kevit Cas..	1·52	...
,, .	Kingussie, The Birches.	2·00	...	*Ferm* .	Enniskillen, Portora....	1·64	...
,, .	Inverness, Culduthel R.	1·35	...	*Arm* .	Armagh Obsy.....	1·25	53
,, .	Loch Quoich, Loan.....	6·93	...	*Down.*	Fofanny Reservoir.....	1·44	...
,, .	Glenquoich.....	5·74	59	,, .	Seaforde	1·09	37
,, .	Arisaig, Faire-na-Sguir.	3·74	...	,, .	Donaghadee, C. Stn....	1·29	59
,, .	Fort William, Glasdrum	5.29	...	,, .	Banbridge, Milltown....	·98	45
,, .	Skye, Dunvegan.....	4·40	...	*Antr* .	Belfast, Cavehill Rd.....	1·96	...
,, .	Barra, Skallary.....	2·36	...	,, .	Aldergrove Aerodrome.	1·47	59
R&C .	Alness, Ardross Castle.	2·36	72	,, .	Ballymena, Harryville.	1·40	44
,, .	Ullapool	4·06	97	*Lon* .	Garvagh, Moneydig....	1·20	...
,, .	Achnashellach.....	5·59	78	,, .	Londonderry, Creggan.	1·50	47
,, .	Stornoway	3·77	92	*Tyr* .	Omagh, Edenfel.....	1·54	49
Suth .	Lairg.....	2·47	80	*Don* .	Malin Head.....	1·34	...
,, .	Tongue	3·29	98	,, .	Killybegs, Rockmount.	1·98	...

Climatological Table for the British Empire, October, 1934

STATIONS.	PRESSURE.		TEMPERATURE.							Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION.			BRIGHT SUNSHINE.	
			Absolute.		Mean Values.				Mean.							
	Mean of Day M.S.L.	Diff. from Normal.	Max.	Min.	Max.	Min.	½ Max. and Min.	Diff. from Normal.	Wet Bulb.			Am'nt.	Diff. from Normal.	Days.	Hours per day.	Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1015·4	+ 1·4	66	29	58·1	46·9	52·5	+ 2·6	48·3	89	7·5	0·87	— 1·83	12	2·6	24
Gibraltar	1018·9	+ 1·7	82	53	74·2	61·5	67·9	+ 1·5	60·5	83	5·3	1·27	— 2·00	5	...	...
Malta	1016·9	+ 0·9	82	58	73·2	63·9	68·5	— 2·4	63·9	80	5·2	2·94	+ 0·07	12	7·3	65
St. Helena	1015·1	+ 0·7	66	53	61·4	55·0	58·2	— 0·1	55·8	94	9·7	1·95	...	21	...	...
Freetown, Sierra Leone	1014·0	+ 2·4	90	70	85·0	72·4	78·7	— 1·4	75·5	88	6·5	12·67	+ 0·05	27	...	...
Lagos, Nigeria	1012·1	+ 1·1	87	70	84·9	74·5	79·7	0·0	75·5	87	8·1	13·45	+ 5·68	20	5·2	44
Kaduna, Nigeria	1008·8	...	91	64	88·0	66·8	77·4	+ 1·1	71·9	86	7·2	2·96	+ 0·21	12	8·1	68
Zomba, Nyasaland	1010·9	0·0	91	54	84·5	62·9	73·7	— 0·4	63·3	55	3·3	2·48	+ 0·96	3	...	...
Salisbury, Rhodesia	1011·3	— 0·7	92	49	82·6	57·6	70·1	— 0·6	57·3	39	1·4	1·67	+ 0·54	5	8·6	69
Cape Town	1017·3	— 0·1	88	43	71·3	55·0	63·1	+ 1·9	56·4	73	4·7	2·10	+ 0·45	12	...	...
Johannesburg	1012·6	0·0	85	37	75·8	52·5	64·1	+ 1·3	52·1	45	3·2	1·70	— 0·86	10	9·1	72
Mauritius	1018·8	+ 0·6	81	56	77·4	63·0	70·2	— 2·5	66·0	63	5·3	1·13	— 0·25	15	8·5	68
Calcutta, Alipore Obsy.	1009·5	+ 0·1	93	69	88·0	75·4	81·7	+ 2·4	75·9	87	4·3	5·36	+ 0·46	8*	...	...
Bombay	1009·9	+ 0·1	96	74	91·3	76·5	83·9	+ 1·5	74·9	76	2·8	0·21	— 1·46	1*	...	...
Madras	1008·6	— 0·3	96	72	88·3	75·4	81·9	— 0·4	77·5	86	6·9	16·82	+ 5·67	13*	...	...
Colombo, Ceylon	1010·3	+ 0·3	88	71	84·5	73·9	79·2	— 1·3	76·4	79	7·1	21·10	+ 7·74	25	6·0	50
Singapore	1009·8	+ 0·1	89	73	85·1	75·3	80·2	— 0·9	77·0	79	9·1	10·30	+ 2·23	20	4·8	40
Hongkong	1014·8	+ 1·1	85	63	79·2	70·6	74·9	— 2·0	68·6	71	7·4	2·21	— 2·73	11	5·1	44
Sandakan	1009·5	...	92	74	89·0	75·5	82·3	+ 0·9	77·7	82	7·5	8·42	— 1·91	24	...	...
Sydney, N.S.W.	1016·0	+ 1·2	83	45	69·3	54·4	61·9	— 1·7	57·6	64	6·1	1·93	— 0·92	12	8·5	66
Melbourne	1015·3	+ 0·5	81	37	66·6	46·4	56·5	— 1·2	52·2	61	6·6	6·16	+ 3·53	20	4·8	37
Adelaide	1015·9	— 0·1	92	41	71·4	51·8	61·6	— 0·4	54·6	53	6·9	2·00	+ 0·27	16	6·7	52
Perth, W. Australia	1017·8	+ 1·0	83	45	69·1	50·6	59·9	— 0·9	54·2	59	3·7	0·98	— 1·24	8	9·0	70
Coolgardie	1014·6	— 0·5	96	39	76·3	47·7	62·0	— 1·7	55·0	53	2·4	0·25	— 0·41	2	...	...
Brisbane	1018·6	+ 2·4	85	50	76·3	58·9	67·6	— 2·2	61·1	57	5·6	1·34	— 1·19	8	7·8	61
Hobart, Tasmania	1010·1	— 0·2	82	36	62·4	46·1	54·3	+ 0·2	48·4	59	6·4	2·69	+ 0·43	22	6·2	47
Wellington, N.Z.	1018·3	+ 5·2	67	39	59·6	47·1	53·3	— 1·1	50·8	77	7·1	6·85	+ 2·77	14	6·3	48
Suva, Fiji	1014·5	+ 1·3	88	66	82·0	70·3	76·1	+ 0·3	72·0	77	6·3	11·48	+ 3·19	15	6·1	49
Apia, Samoa	1011·6	+ 0·1	87	71	85·3	73·2	79·3	+ 0·9	75·7	75	5·4	4·90	— 1·48	14	7·9	64
Kingston, Jamaica	1011·9	+ 0·4	92	69	87·3	72·5	79·9	— 0·6	71·9	87	5·1	3·72	— 3·74	11	5·3	45
Grenada, W.I.	...	...	88	70	85	71	78	— 2·1	73	82	6	12·86	+ 5·10	21	...	...
Toronto	1017·3	— 0·2	73	28	55·9	41·2	48·5	— 0·1	41·8	79	5·8	1·31	— 1·26	6	5·4	49
Winnipeg	1015·6	+ 0·7	82	19	54·1	36·7	45·4	+ 4·7	38·2	86	6·6	0·42	— 0·95	7	4·1	38
St. John, N.B.	1013·2	— 2·6	67	30	51·7	39·4	45·5	+ 0·2	41·0	78	6·1	4·12	— 0·42	13	4·6	42
Victoria, B.C.	1014·7	— 2·4	72	42	57·8	47·0	52·4	+ 2·1	49·6	86	6·2	2·34	— 0·23	16	4·8	44

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(25603) Wt. 18/32 1,000 4/35 Hw. G.377